

REMARKS/ARGUMENTS

Reconsideration and allowance of this application are respectfully requested. Currently, claims 1-10 are pending in this application. Claims 8-10 have been added.

The Rejections of Claims 1-7 under 35 U.S.C. § 103(a)

Claims 1, 6, and 7 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over non-patent literature documents – namely, an article by Razvan Surdulescu entitled “Cg Shadow Volumes” in view of an article by Tim Heidmann entitled “Real Shadows Real Time.” Claims 2-5 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Surdulescu in view of Heidmann and Matsumoto (U.S. Patent No. 5,043,922). These Section 103 rejections are respectfully traversed.

In order to establish a *prima facie* case of obviousness, all of the claim limitations must be taught or suggested, and the references must be combinable in an appropriate manner. Surdulescu, Heidmann, and the alleged combination thereof disclose only a general shadow polygon technique. None of Surdulescu, Heidmann, or the alleged combination thereof teach or suggest “generating the shadow volume from a plane object by determining a position of each vertex of a plurality of polygons composing the plane object, with regard to a direction perpendicular to a surface of the plane object in accordance with the Z value of each pixel written in the Z-buffer,” as required by claim 1 and its dependents. Claims 6 and 7 incorporate similar features to this limitation of claim 1. Thus, the alleged combination of Surdulescu and Heidmann fail to render obvious claims 1-7.

To demonstrate the differences between Surdulescu, Heidmann, and the alleged combination thereof, Applicant provides the following textual and visual comparisons. The image generating method of Surdulescu (which includes a shadow rendering method) involves:

- A) In a state where a light source is “turned off,” the entire scene viewed from a viewpoint is rendered, wherein the entire scene is covered by a shadow and is stored in a color buffer;
- B) Using shadow polygons and a stencil buffer, a shadowed area viewed from the viewpoint is detected; and
- C) In a state where the light source is “turned on,” only the lit portion of the scene (an area where the corresponding stencil buffer values are 0) viewed from the viewpoint is rendered (color buffer values are at least partly overwritten), whereby the image that includes the shadow is stored in the color buffer.

The shadow polygons used in Step B above are generated by extruding (e.g., pushing out) the extremities of the segment along the light direction.

In marked contrast to this technique of the alleged combination of Surdulescu and Heidmann, claim 1 generates shadow polygons and shadow volumes in accordance with the following steps:

- 1) A shadow casting object viewed from a viewpoint is rendered. As a result, Z-values that represent distances from respective points on the shadow casting object to the light source are stored in the Z-buffer.
- 2) Based on the Z-values stored in the Z-buffer in Step 1, the shadow polygons are generated using a plane object.

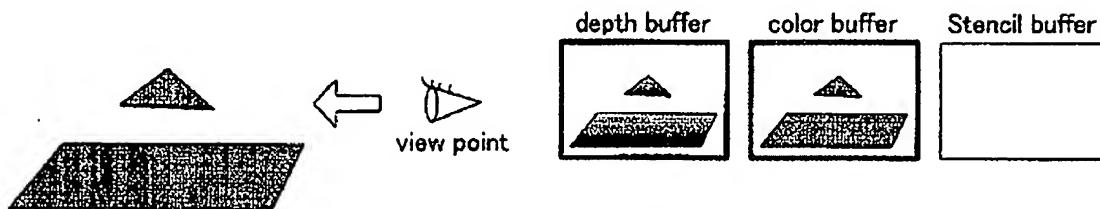
To further highlight the differences between the prior art techniques and the techniques of the claimed invention, Applicant provides the following illustrative diagrams:

TECHNIQUES TAUGHT BY SURDULESCU

Step A

(step 1 in page 4)

● light source (off)

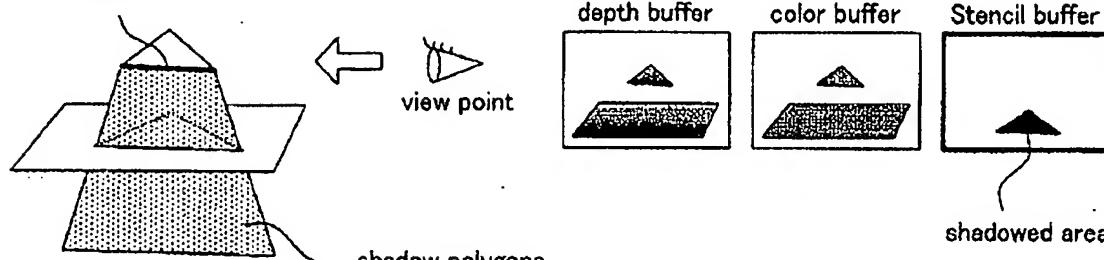


Step B

(steps 2 to 4 in page 4)

○ light source

outline segment

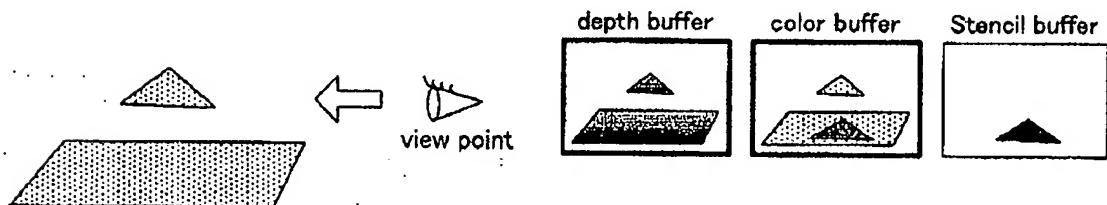


(created by extruding (pushing out) the extremities
of each outline segment along the light, see page 3)

Step C

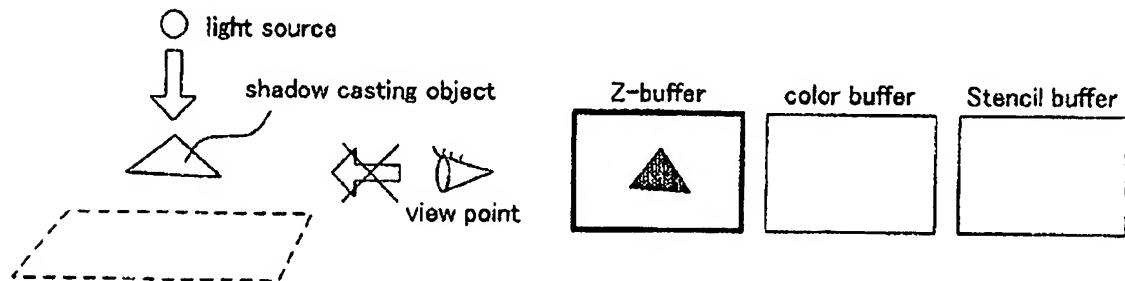
(steps 5 to 6 in page 4)

○ light source (on)

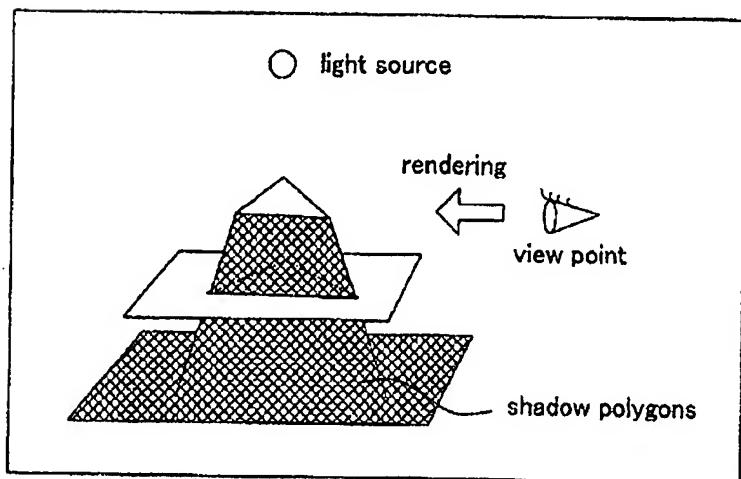
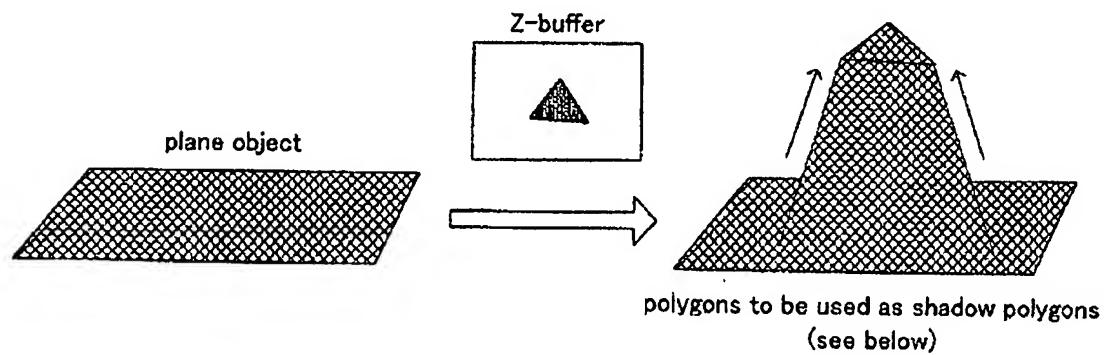


ILLUSTRATIVE TECHNIQUES OF THE CLAIMED INVENTION

Step1



Step2



In view of the above, Applicant respectfully submits that the shadow polygon/shadow volume of claim 1 is neither taught nor suggested by Surdulescu, Heidmann, or the alleged combination thereof.

New Claims 8-10

Surdulescu discloses a flat shadow generation technique, the Z-Pass algorithm, and the Z-Fail algorithm. Applicant notes, however, that all of these techniques of Surdulescu are typical of the techniques described in the Background and Summary section of the instant application, in that it uses edge detection to generate shadow volumes. However, the instant application identifies such techniques as being disadvantageous in that they require special exception case handling. Surdulescu itself identifies problems with both the Z-Pass and the Z-Fail algorithms. In particular, neither algorithm is capable of rendering shadows for models that have missing faces or “holes.” In such a case, as Surdulescu admits, “a shadow volume outline segment might be skipped (since outline segments are defined as a [sic] shared edges between two faces).” Heidmann appears to add only technical details to the basic Z-Pass techniques disclosed in Surdulescu. As such, Heidmann does not make up for this technical deficiency with respect to Surdulescu.

In marked contrast, the invention defined by the claims is capable of handling such shapes in an advantageous manner while also reducing exception case handling. For example, Figures 1E-1H and 2B visually demonstrate the shadow generation technique of the claimed invention being successfully applied to a donut-shaped object. Thus, Surdulescu and Heidmann, alone and in combination, involve disadvantageous techniques, are incapable of performing the functionality enabled by the claimed invention without the use of exception handling, and fail to render obvious the claimed invention.

To further emphasize the differences between the prior art and the claimed invention, dependent claims 8-10 have been added. More particularly, dependent claims 8-10 each specify that the shadow volume generation technique reduces exception case handling. Support for such limitations can be found, for example, in paragraphs 8, 11, 12, and 17 of the original specification.

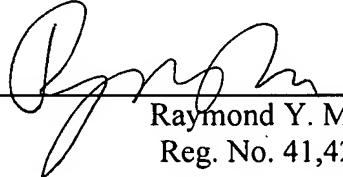
Conclusion

Applicant believes that this entire application is in condition for allowance and respectfully requests a notice to this effect. If the Examiner has any questions or believes that an interview would further prosecution of this application, the Examiner is invited to telephone the undersigned.

Respectfully submitted,

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